Machinists

(0*NET 51-4041.00)

Significant Points

- Machinists learn in apprenticeship programs, informally on the job, and in high schools, vocational schools, or community or technical colleges.
- Many entrants previously have worked as machine setters, operators, or tenders.
- Job opportunities are expected to be excellent.

Nature of the Work

Machinists use machine tools, such as lathes, milling machines, and machining centers, to produce precision metal parts. Although they may produce large quantities of one part, precision machinists often produce small batches or one-of-a-kind items. They use their knowledge of the working properties of metals and their skill with machine tools to plan and carry out the operations needed to make machined products that meet precise specifications.

Before they machine a part, machinists must carefully plan and prepare the operation. These workers first review blueprints or written specifications for a job. Next, they calculate where to cut or bore into the workpiece (the piece of metal that is being shaped), how fast to feed the metal into the machine, and how much metal to remove. They then select tools and materials for the job, plan the sequence of cutting and finishing operations, and mark the metal stock to show where cuts should be made.

After this layout work is completed, machinists perform the necessary machining operations. They position the metal stock on the machine tool—drill press, lathe, milling machine, or other type of machine—set the controls, and make the cuts. During the machining process, they must constantly monitor the feed rate and speed of the machine. Machinists also ensure that the workpiece is being properly lubricated and cooled, because the machining of metal products generates a significant amount of heat. The temperature of the workpiece is a key concern because most metals expand when heated; machinists must adjust the size of their cuts relative to the temperature. Some rare but increasingly popular metals, such as titanium, are machined at extremely high temperatures.

Machinists detect some problems by listening for specific sounds—for example, a dull cutting tool or excessive vibration. Dull cutting tools are removed and replaced. Cutting speeds are adjusted to compensate for harmonic vibrations, which can decrease the accuracy of cuts, particularly on newer high-speed spindles and lathes. After the work is completed, machinists use both simple and highly sophisticated measuring tools to check the accuracy of their work against blueprints.

Some machinists, often called production machinists, may produce large quantities of one part, especially parts requiring the use of complex operations and great precision. Many modern machine tools are computer numerically controlled (CNC). Frequently, machinists work with computer-control programmers to determine how the automated equipment will cut a part. (See the statement on computer control programmers and operators elsewhere in the *Handbook*.) The programmer may determine the path of the cut, while the machinist determines the type of cutting tool, the speed of the cutting tool, and the feed rate. Because most machinists train in CNC programming, they may write basic programs themselves and often modify programs in response to problems encountered during test runs. After the production process is designed, relatively simple and repetitive operations normally are performed by machine setters, operators, and tenders. (See the statement on machine setters, operators, and tenders—metal and plastic, elsewhere in the *Handbook*.)

Some manufacturing techniques employ automated parts loaders, automatic tool changers, and computer controls, allowing machine tools to operate without anyone present. One production machinist, working 8 hours a day, might monitor equipment, replace worn cutting tools, check the accuracy of parts being produced, and perform other tasks on several CNC machines that operate 24 hours a day (lights-out manufacturing). During lights-out manufacturing, a factory may need only a few machinists to monitor the entire factory.

Other machinists do maintenance work—repairing or making new parts for existing machinery. To repair a broken part, maintenance machinists may refer to blueprints and perform the same machining operations that were needed to create the original part.

Working Conditions

Today, most machine shops are relatively clean, well lit, and ventilated. Many computer-controlled machines are partially or totally enclosed, minimizing the exposure of workers to noise, debris, and the lubricants used to cool workpieces during machining. Nevertheless, working around machine tools presents certain dangers, and workers must follow safety precautions. Machinists wear protective equipment, such as safety glasses to shield against bits of flying metal and earplugs to dampen machinery noise. They also must exercise caution when handling hazardous coolants and lubricants, although many common water-based lubricants present little hazard. The job requires stamina, because machinists stand most of the day and, at times, may need to lift moderately heavy workpieces. Modern factories extensively employ autoloaders and overhead cranes, reducing heavy lifting.

Most machinists work a 40-hour week. Evening and weekend shifts are becoming more common as companies justify investments in more expensive machinery by extending hours of operation. However, this trend is somewhat offset by the increasing use of lights-out manufacturing. Overtime is common during peak production periods.

Employment

Machinists held about 387,000 jobs in 2002. Most machinists work in small machining shops or in manufacturing industries, such as machinery manufacturing and transportation equipment manufacturing (motor vehicle parts and aerospace products and parts). Main-

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tenance machinists work in most industries that use production machinery.

Training, Other Qualifications, and Advancement

Machinists train in apprenticeship programs, informally on the job, and in high schools, vocational schools, or community or technical colleges. Experience with machine tools is helpful. In fact, many entrants previously have worked as machine setters, operators, or tenders. Persons interested in becoming machinists should be mechanically inclined, have good problem-solving abilities, be able to work independently, and be able to do highly accurate work (tolerances may reach 1/10,000th of an inch) that requires concentration and physical effort.

High school or vocational school courses in mathematics (especially trigonometry), blueprint reading, metalworking, and drafting are highly recommended. Apprenticeship programs consist of shop training and related classroom instruction lasting up to 4 years. In shop training, apprentices work almost full time, and are supervised by an experienced machinist while learning to operate various machine tools. Classroom instruction includes math, physics, materials science, blueprint reading, mechanical drawing, and quality and safety practices. In addition, as machine shops have increased their use of computer-controlled equipment, training in the operation and programming of CNC machine tools has become essential. Apprenticeship classes are taught in cooperation with local community or vocational colleges. A growing number of machinists learn the trade through 2-year associate degree programs at community or technical colleges. Graduates of these programs still need significant on-the-job experience before they are fully qualified.

To boost the skill level of machinists and to create a more uniform standard of competency, a number of training facilities and colleges are implementing curriculums that incorporate national skills standards developed by the National Institute of Metalworking Skills (NIMS). After completing such a curriculum and passing a performance requirement and written exam, trainees are granted a NIMS credential, which provides formal recognition of competency in a metalworking field. Completing a recognized certification program provides a machinist with better career opportunities.

As new automation is introduced, machinists normally receive additional training to update their skills. This training usually is provided by a representative of the equipment manufacturer or a local technical school. Some employers offer tuition reimbursement for job-related courses.

Machinists can advance in several ways. Experienced machinists may become CNC programmers, tool and die makers, or mold makers, or be promoted to supervisory or administrative positions in their firms. A few open their own shops.

Job Outlook

Despite projected slower-than-average employment growth, job opportunities for machinists should continue to be excellent. Many young people with the necessary educational and personal qualifications needed to obtain machining skills may prefer to attend college or may not wish to enter production occupations. Therefore, the number of workers obtaining the skills and knowledge necessary to fill machinist jobs is expected to be less than the number of job openings arising each year from employment growth and from the need to replace experienced machinists who transfer to other occupations or retire.

Employment of machinists is expected to grow more slowly than the average for all occupations over the 2002-12 period because of rising productivity among these workers. Machinists will become more efficient as a result of the expanded use of and improvements in technologies such as CNC machine tools, autoloaders, and high-speed machining. This allows fewer machinists to accomplish the same amount of work previously performed by more workers. Technology is not expected to affect the employment of machinists as significantly as that of most other production occupations, however, because machinists monitor and maintain many automated systems. Due to modern production techniques, employers prefer workers, such as machinists, who have a wide range of skills and are capable of performing almost any task in a machine shop.

Employment levels in this occupation are influenced by economic cycles—as the demand for machined goods falls, machinists involved in production may be laid off or forced to work fewer hours. Employment of machinists involved in plant maintenance, however, often is more stable because proper maintenance and repair of costly equipment remain critical to manufacturing operations, even when production levels fall.

Earnings

Median hourly earnings of machinists were $15.66 in 2002. The middle 50 percent earned between $12.15 and $19.45. The lowest 10 percent earned less than $9.57, while the top 10 percent earned more than $23.17. Median hourly earnings in the manufacturing industries employing the largest number of machinists in 2002 were:

Metalworking machinery manufacturing	$16.75
Other general purpose machinery manufacturing	15.91
Machine shops; turned product; and screw, nut, and bolt manufacturing	15.45
Motor vehicle parts manufacturing	15.18
Employment services	9.41

Related Occupations

Occupations most closely related to that of machinist are other machining occupations, which include tool and die makers; machine setters, operators, and tenders—metal and plastic; and computer-control programmers and operators. Another occupation that requires precision and skill in working with metal is welding, soldering, and brazing.

Sources of Additional Information

For general information about machinists, contact:

➤ Precision Machine Products Association, 6700 West Snowville Rd., Brecksville, OH 44141-3292. Internet: **http://www.pmpa.org**

For a list of training centers and apprenticeship programs, contact:

➤ National Tooling and Machining Association, 9300 Livingston Rd., Fort Washington, MD 20744. Internet: **http://www.ntma.org**

For general occupational information and a list of training programs, contact:

➤ Precision Metalforming Association Educational Foundation, 6363 Oak Tree Blvd., Independence, OH 44131-2500. Internet: **http://www.pmaef.org**